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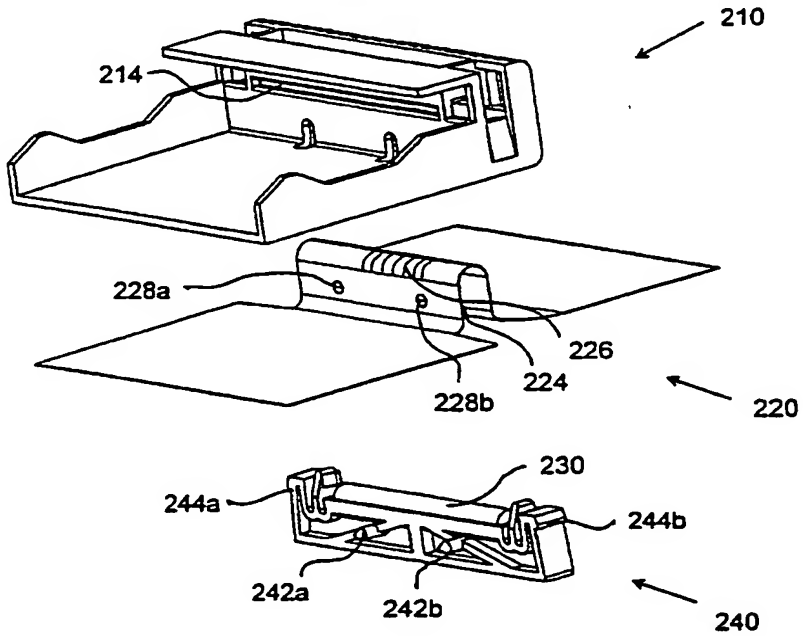
(54) Title: AN ANTENNA DEVICE CONNECTABLE TO A MATING CONNECTOR



(57) Abstract: An antenna device is connectable to a mating connector in e.g. a mobile phone. The antenna device comprises a frame (210) and a flexible film (220) having a conducting layer comprising an antenna pattern thereon. The film is mounted on the frame. An elastic piece (230) is arranged, in mated position of the device, to exert a pressure on said film, thereby pressing the conducting layer on said film into contact with the electrically conducting portion of the mating connector.

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AN ANTENNA DEVICE CONNECTABLE TO A MATING CONNECTOR

FIELD OF INVENTION

The present invention relates generally to antenna devices and more particularly to antenna devices adapted for mounting in radio communication devices such as mobile phones.

BACKGROUND

It is previously known antenna devices in mobile phones wherein the antenna is connected directly to the electric circuitry of the phone by means of different types of feeding lines or the like. However, this solution has several drawbacks, one of which is that the connection area normally is very limited, thus limiting the bandwidth. Also, the antenna is difficult and time-consuming to assemble. The connector itself contributes to the weight of the mobile phone.

OBJECTS OF THE INVENTION

An object of the present invention is to provide an antenna device that gathers all antenna patterns to one carrier.

Another object is to provide an antenna device with an extended RF connection possibility.

Another object is to provide an antenna device with an easy and well-defined connection to other electric elements.

Another object is to provide an antenna device wherein several antenna patterns are provided.

Another object is to provide an antenna device wherein both an inbuilt antenna and an external antenna are provided.

SUMMARY OF THE INVENTION

According to the invention there is provided an antenna device connectable to a mating connector having an electrically conducting portion, said device comprising a frame, and a flexible film having a conducting layer comprising an antenna pattern thereon, said film being mounted on said frame, characterised by an elastic piece arranged, in mated position of the device, to exert a pressure on said film, thereby pressing the conducting layer on said film into contact with the electrically conducting portion of the mating connector.

There is also provided a radio communication device comprising such an antenna device.

Further preferred embodiments are defined in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The invention is now described, by way of example, with reference to the accompanying drawings, in which:

fig. 1 is an perspective view of the different parts of a first embodiment of an antenna according to the invention;

fig. 2 is a perspective view of the antenna device of fig. 1 after assembly but before connection to a printed circuit board;

fig. 3 is a longitudinal cross-section of the assembled antenna device of fig. 2 before connection to a printed circuit board;

fig. 4 is a perspective view of the antenna device of fig. 2 after connection to a printed circuit board;

fig. 5 is a longitudinal cross-section of the assembled antenna device of fig. 4 after connection to a printed circuit board;

fig. 6 is an perspective view of the different parts of a second embodiment of an antenna device according to the invention;

fig. 7 is a perspective view of the antenna device of fig. 6 in a first stage of assembly;

fig. 8 is a perspective view of the antenna device of fig. 6 in a second stage of assembly;

fig. 9 is a perspective view of the antenna device of fig. 6 in an assembled state;

fig. 10 is a view showing the antenna device of fig. 9 just before mounting to a printed circuit board;

fig. 11 is a view showing the antenna device of fig. 9 mounted to the printed circuit board in a mobile phone casing;

fig. 12 is an perspective view of the different parts of a third embodiment of an antenna device according to the invention;

fig. 13 is a longitudinal cross-section of the antenna device of fig. 12 after assembly but before connection to a printed circuit board;

fig. 14 is a perspective view from above of the antenna device of fig. 12 in assembled state;

fig. 15 is a perspective view from the underside of the antenna device of fig. 12 in assembled state;

fig. 16 is an perspective view of the different parts of a fourth embodiment of an antenna device according to the invention;

fig. 17 is a detailed perspective view of a connection point to a rod antenna of the antenna device of fig. 16 before assembly;

fig. 18 is a detailed perspective view of a connection point to a rod antenna of the antenna device of fig. 16 in assembled state; and

fig. 19 is a perspective view of the antenna device of fig. 16 mounted in a mobile phone.

DETAILED DESCRIPTION OF THE INVENTION

Reference is first made to fig. 1 wherein the main parts of a first embodiment of an antenna device according to the invention are shown. A main frame or body 10 of the antenna device is made of a non-conducting material such as a suitable plastic material. The main frame has a flat, generally rectangular configuration. In one end, to the left in fig. 1, the main frame has a thicker portion, designated 12 wherein a female connector is located in the form of a recess or cut-in portion 14, the function of which will be described later. There are also two pins 16a, 16b for positioning of a flex film and a locking element, as will be described below.

The flex film 20 is provided with an antenna pattern (not shown). The film is rectangular and has a width essentially corresponding to the width of the main frame 10 and a length exceeding the length of the main frame. Close to one end thereof, the film 20 has two holes 22a, 22b matching

the pins 16a, 16b of the main frame. During assembly, the film 20 is threaded onto the pins in order to position the film relative to the main frame. At the same end as the holes, the film 20 is provided with two slits 24a, 24b together forming a tongue 26 that will be positioned directly above the recess 14 of the main frame. The tongue is provided with electrically conducting portions connected to the antenna pattern and facing the main frame. These conducting portions form the connecting elements of the connector of the antenna device, as will be described below.

The antenna device also comprises an elongated, essentially circular element 30 made of an elastic material such as a foamed plastic, silicone or the like. The element 30 is sized to fit into the recess 14 of the main frame 10. There is also a locking element 40 made of plastic. The locking element has a recess 42 corresponding to the element 30 of the main frame. It is also provided with two holes 44a, 44b adapted for receiving the pins 16a, 16b of the main frame.

Finally, there is a flexible sheet (not shown) with adhesive material for attaching the film 20 to the main frame 10.

The assembly of the antenna device of fig. 1 will now be described with reference to figures 2 and 3. First, the film 20 is threaded onto the main frame 10 by means of the pins 16a, 16b and the corresponding holes 22a, 22b. Then, the element 30 is put into the recess 42 of the locking element 40 which is then fixed to the main frame 10 by means of the pins 16a, 16b and the holes 44a, 44b. The locking element 40 is fixed in place by means of heat staking, mechanical deformation, glue or the like.

The film 20 is then wrapped around the locking element 40 and fixed to the back of the main frame 10 by means of the adhesive sheet provided with an adhesive on both sides thereof. The antenna device will then have the shape shown in figures 2 and 3. In fig. 3 there is shown how the circular element 30 presses against the film 20 in the area of the recess 14. This pressure will be used in a connected position as will now be described with reference to figures 4 and 5.

In figs. 4 and 5 is shown how the antenna device 2 has been slid onto a printed circuit board (PCB) 60 provided with an edge connector 62 with electrically conducting paths 64. The edge connector 62 has a width essentially corresponding to the width of the female connector of the antenna device 2, i.e., the width of the recess 14 in the main frame 10. The female connector of the antenna device formed by the recess 14 and the male edge connector 62 of the PCB are aligned and the antenna device 2 is then slid onto the PCB. The edge connector 62 then enters the recess 14, displacing the tongue 26 and compressing the element 30 during the entry process. Fully inserted the electrically conducting paths 64 of the edge connector 62 contacts the conducting portions of the tongue 26 by means of the pressure exerted by the compressed element 30, thus connecting the antenna element of the antenna device 2 to the electric circuitry of the PCB 60, e.g. the RF part of the electric circuitry of a mobile phone.

The above-described solution provides several advantages. The antenna pattern can be varied within the dimensions given by the size of the main frame 10, thus enabling many different applications. Also, the antenna pattern can easily be changed during development or service without

affecting the final design. The size of the conducting paths 28, 64 of the female and male connectors, respectively, can be varied to suit the application. It also gives a well-defined connecting area on the telephone PCB and a well-defined mechanical interface between the antenna and the telephone PCB, with a secure snap in fit there between.

The male-female connector solution provides for the easy assembly of the antenna in the workshop of the manufacturer. Finally, the easy assembly together with the small number of parts of the antenna device, they can be as few as three, provides an inexpensive solution.

Another possibility is to provide an antenna pattern on both sides of the flex film, e.g. matching patterns. Also, electric components can be soldered to the flex film.

The entire device is made of low weight materials, mainly plastics. This is an advantage especially in mobile phones.

The antenna pattern and the telephone PCB are in different substantially parallel planes with a well-defined mutual distance. This is a preferred configuration in mobile phones wherein the PCB functions as a ground plane for the antenna.

In the following, a second embodiment of the present invention will be described with reference to figures 6-10. Fig. 6 shows the different parts of an antenna device, namely a main frame 110, a flex film 120 and a locking element 140. The main frame 110 is made of plastics. However, on the edges thereof there are provided strips 130 of an elastic material. During manufacturing, the strips 130 are provided on the main frame 110 by means of a double moulding

process, i.e., the main frame 110 is first made in a mould without the strips 130 and the strips are then moulded onto the main frame by means of a second mould.

The main frame 110 is also provided with hooks 112 for snap fit with a printed circuit board, which will be described below with reference to fig. 10. There are also provided pins or protrusions 114a, 114b for positioning of the flex film 120 thereon.

The flex film 120 is provided with a radiating pattern or antenna pattern 122 of some suitable conducting material. Four wings 124a-d extend from the central portion of the flex film 120, the widths of said wings being essentially equal to the width of a respective side of the main frame 110. The antenna pattern is connected to connecting paths close to the edges of the wings 124a-d, of which paths one 126a shown in fig. 6. The flex film is also provided with two holes 128a, 128b adapted for receiving the pins 114a, 114b for positioning of the flex film on the main frame 110.

The locking element 140 is essentially rectangular and sized to fit into the main frame 110. It is provided with protrusions on the sides thereof, of which two 142a, 142b are shown in the figures.

The assembly of the parts shown in fig. 6 will now be explained with reference to figs. 7-9. The flex film 120 is put on a flat surface with the antenna pattern and the connecting paths facing down. The main frame 110 is then positioned on top of the flex film and centred thereon by means of the pins 114a, 114b and the holes 128a, 128b, see fig. 6. The four wings 124a-d of the flex film are in that

position aligned with a respective side of the main frame 110.

The wings 124a-d are then wrapped tightly around the sides of the main frame 110, see fig. 8, and fixed thereto by means of an adhesive on the surface of the flex film 120 facing the main frame 110. In that way, they cover the elastic strips 130 of the main frame. The ring-shaped locking element 140 is then pressed down into the main frame, thereby further locking the wings 124a-d in position and preventing them from coming unglued should the adhesive fail. The locking element is fixed in place by means of the protrusions 142a, 142b and corresponding recesses in the main frame (not shown).

The assembled antenna device 102 is shown in fig. 9. The conducting paths 126a-d of the wings face upward in fig. 9, ready for contact with corresponding conducting paths on a PCB 160 adapted for mounting in a mobile phone casing 170, see figs. 10 and 11. In fig. 11, the antenna device 102 has been attached to the PCB 160 by means of the hooks 112 of the main frame 110. The elastic portions 130 of the main frame are then slightly compressed whereby they exert a pressure on the wings 124a-d covering them. In that way, the conducting paths 126a-d on the wings are pressed against corresponding conducting paths of the PCB 160, whereby providing connection between the antenna pattern and the electric circuitry on the PCB 160, e.g., a RF part thereof.

A third embodiment of an antenna device according to the invention will now be described with reference to figs. 12-15. In fig. 12, a main frame 210 is shown provided with a thicker portion 212 provided with an opening 214 adapted

for receiving an edge connector 262 of a PCB 260, see fig. 14.

In fig. 12 is also shown a flex film 220 provided with an antenna pattern. It is also provided with electrically conducting paths 226 on a central narrower waist portion 224 thereof. This central portion 224 has a width corresponding to the width of the opening 214 and is adapted to be inserted therein from the underside of the main frame 210.

An elongated locking element 240 is provided to position the flex film 220 in the opening 214. The locking element is provided with an elastic string 230 similar to that described in connection with the second embodiment. The locking element also comprises two pins 242a, 242b adapted for co-operation with corresponding holes 228a, 228b in the flex film 220 in order to position the flex film.

The assembly of the parts shown in fig. 12 will now be described. First, the flex film 220 is placed over the locking element 240 positioned by means of holes 228a, 228b in the film and corresponding pins 242a, 242b on the locking element. The locking element 240 is then pressed into the opening 214 from below and fixed in place by means of two resilient hooks 244a, 244b on the locking element that are seated in corresponding recesses in the opening 214. The film is then attached to the main frame 210 by means of an adhesive or the like, which completes the assembly.

In fig. 14, a PCB 260 is about to be inserted into the opening 214 of the main frame. The PCB is provided with an edge connector 262 with a width corresponding to that of the opening 214. The edge connector 262 is provided with conducting paths of the underside thereof (not shown in

fig. 14). In an inserted position of the PCB, see fig. 15, the elastic portion 230 presses the conducting paths 226 on the flex film into contact with the conducting paths of the edge connector 260, thereby establishing electrical connection between the antenna pattern and the PCB.

An antenna pattern can be provided on both of the wider portions of the film 220 surrounding the waist portion 224. Thus, an advantage with the third embodiment described with reference to figs. 12-14 is the short distance from the connector conducting paths 226 of the central waist portion 224 to the antenna pattern(s) on the film 220.

A fourth embodiment of an antenna device according to the invention will now be described with reference to figs. 16-19. This fourth embodiment is similar to the second embodiment but is also adapted for connection to a rod antenna. The main frame 310 is provided with a cut-out portion 312 in one edge thereof and close to a corner. In an adjacent edge, close to the same corner, is a cut-out portion for a relatively narrow strip 322 of the flex film 320. The strip 322 rests on a piece of elastic material 332 adapted for reception of an electrically conducting base portion 372 of a rod antenna 370.

A locking element 340 is provided with a support 342 for the antenna base 372 in one corner thereof. The support is also provided with an elastic portion 344 for abutment of the antenna base. The locking element is further provided with four resilient hooks, of which two 346a, 346b are shown in fig. 17, for a snap-in function during assembly.

The assembled antenna device is shown in fig. 18. The locking element 340 has been snapped into place, thereby press-

ing the base portion 372 of the rod antenna 370 into contact with the strip 322, ensuring electrical contact between the base portion and the flex film.

In fig. 19, the antenna device 302 of fig. 18 is shown mounted in a mobile phone casing 380. Thus, the antenna device provides for easy and secure mounting of an extendible rod antenna together with an inbuilt antenna.

Preferred embodiments of antenna devices comprising a connector assembly according to the invention have been described. The person skilled in the art realises that these could be varied within the scope of the invention as defined by the appended claims.

Thus, in the first embodiment shown in figs. 1-5, there could be provided more than one recess 14 and corresponding tongues, elastic pieces and locking elements, thereby providing more than one connector. In that way, the antenna device 2 could be connected to more than one PCB.

The frame 110 of the second embodiment is shown with an square upper surface. However, the frame can have any suitable shape such as triangular, rectangular etc.

In the third embodiment shown in figs. 12-15, there is only one locking element. However, there could also be a locking element inserted into an opening in the frame from above, thereby making possible the use of double-sided edge connectors of the PCB.

The expression mating connectors has been used in this application. This expression is intended to cover all types of electrical connectors.

CLAIMS

1. An antenna device connectable to a mating connector having an electrically conducting portion, said device comprising

a frame (10;110;210;310), and

a flexible film (20;120;220;320) having a conducting layer comprising an antenna pattern thereon, said film being mounted on said frame,

characterised by

an elastic piece (30;130;230;330) arranged, in mated position of the device, to exert a pressure on said film, thereby pressing the conducting layer (28;126) on said film into contact with the electrically conducting portion (64;162;262;372) of the mating connector (62;162;262;372).

2. A device according to claim 1, **characterised in that** said elastic piece (30;130;230;330) is made of syntethic or natural rubber, preferably silicone, or foamed plastics.

3. A device according to claim 1, **characterised in that** said elastic piece (30;130;230;330) is made of elastic string.

4. A device according to any of the preceding claims, **characterised in that** both sides of said film (20;120) have a conducting layer comprising an antenna pattern.

5. A device according to any of the preceding claims, **characterised in that** said film

(20;120;220;320) is mounted to the frame (10;110;210;310) by means of an adhesive.

6. A device according to any of the preceding claims, **characterised in that** said frame (210;310) comprises location pins (16a,b;114a,b) for positioning said film (220;320) by means of corresponding holes (22a,b;128a,b) in the film.

7. A device according to any of the preceding claims, **characterised by** discrete electric components mounted on said film (20;120;220;320), preferably matching components for the antenna.

8. A device according to any of the preceding claims, **characterised by** electric components integrated into the conducting layer of said film (20;120;220;320), preferably matching components for the antenna.

9. A device according to any of the preceding claims, **characterised by** a locking element (40;240) for positioning said elastic piece (30;230).

10. A device according to claim 9, **characterised in that** said frame (10) comprises a thicker portion (12) having a recess (14) into which a part of the film (20) is pressed by means of the elastic piece (30), said piece being held in place by means of the locking element (40).

11. A device according to any of claims 1-8, **characterised in that** said frame (110) is essentially box shaped with four sides and in that said film (120) is fixed to the frame (110) by means of a locking

element (140) pressing the film against the sides of the frame.

12. A device according to claim 11, **characterised in that** said elastic piece (130) is attached to the edge of at least one of said sides and said film (120) is wrapped around the edge and around said elastic piece.

13. A device according to any of claims 1-8, **characterised in that** said frame (210) having an opening (214) adapted for receiving said film (220) and comprising said elastic piece (230) held in place by means of a locking element (240), wherein said opening is adapted for receiving the mating connector.

14. A device according to any of claims 1-8, **characterised in that** said film (320) is provided with an extending strip (322) positioned on the elastic piece (332), wherein a locking element (340, 342, 344) is provided for pressing the mating connector (372) of a rod antenna (370) into contact with said strip (332).

15. A device according to any of claims 1-13, **characterised in that** said mating connector is provided on a printed circuit board (60;160;260) of a radio communication device.

16. A device according to claim 15, **characterised in that** said antenna pattern is adapted to be mounted substantially parallel to and spaced apart from said printed circuit board (60;160;260).

17. A device according to claim 15 or 16, **characterised in that** said frame (110) comprises hook

means (112) for snap fitting to the printed circuit board (160).

18. A device according to claim 15 or 16, **characterised in that** said mating connector is an edge connector (62;262) of the printed circuit board (60;260).

19. A device according to claim 17, **characterised in that** said mating connector is conducting paths (162) of the printed circuit board (160).

20. A radio communication device, **characterised by** an antenna device according to any of the preceding claims.

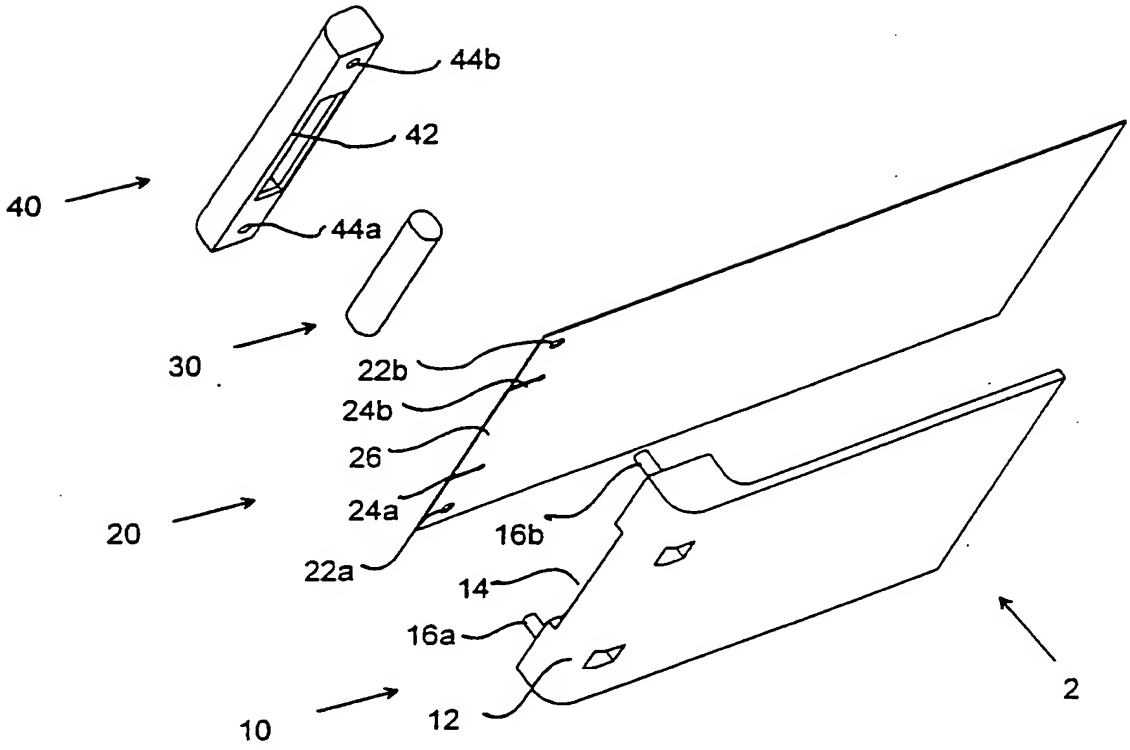

44b
42
40
44a
30
22b
24b
26
24a
20
22a
16b
14
16a
10
12
2

Fig. 1

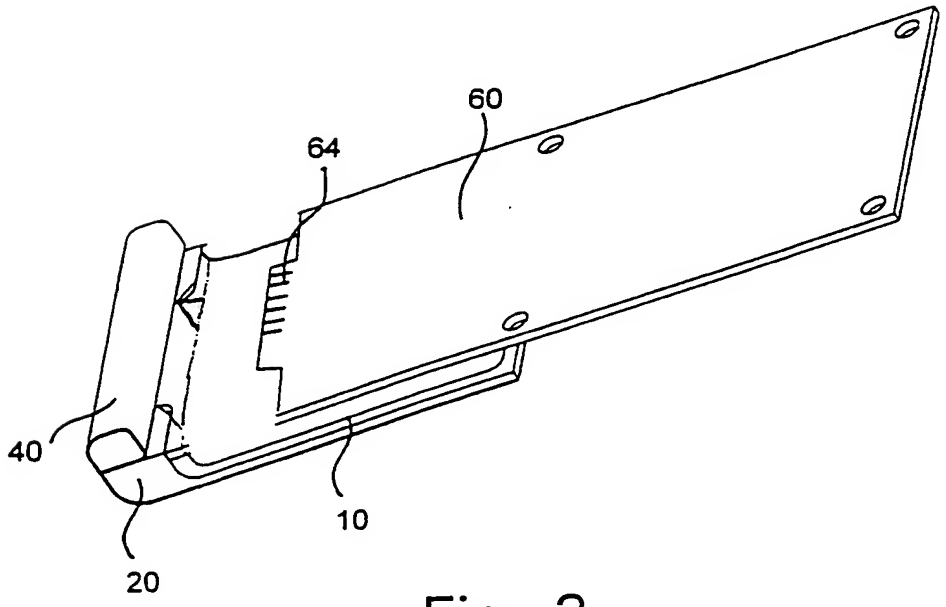

60
64
40
10
20

Fig. 2

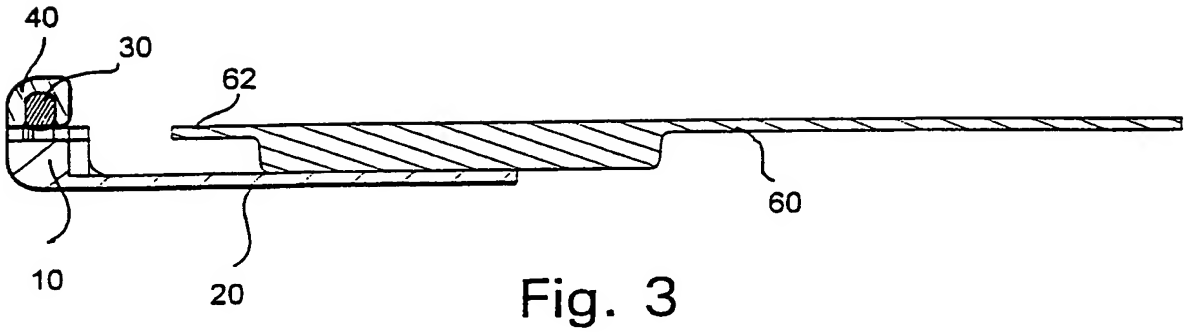


Fig. 3

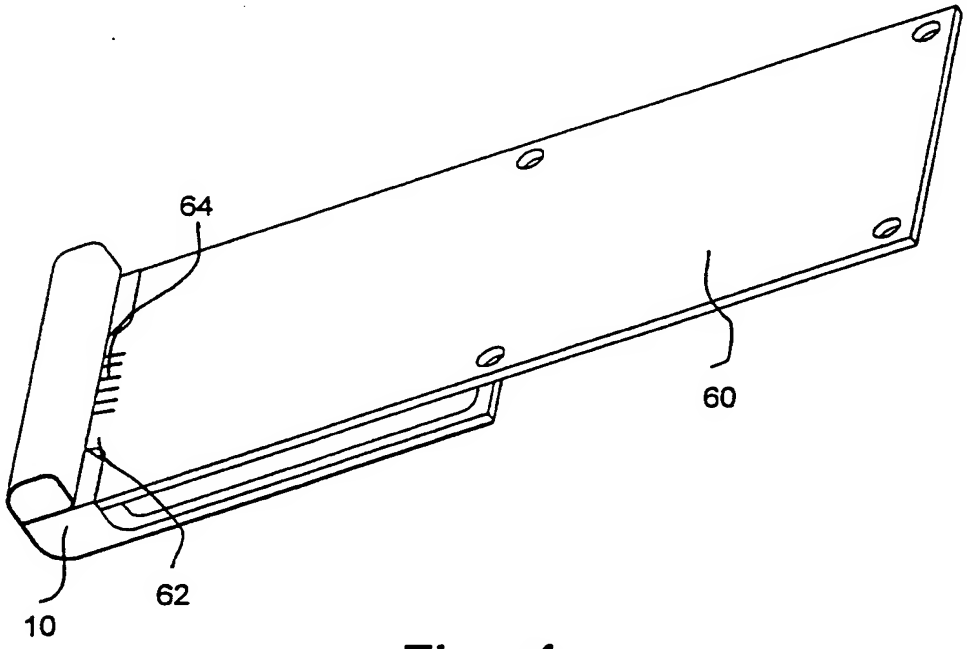


Fig. 4

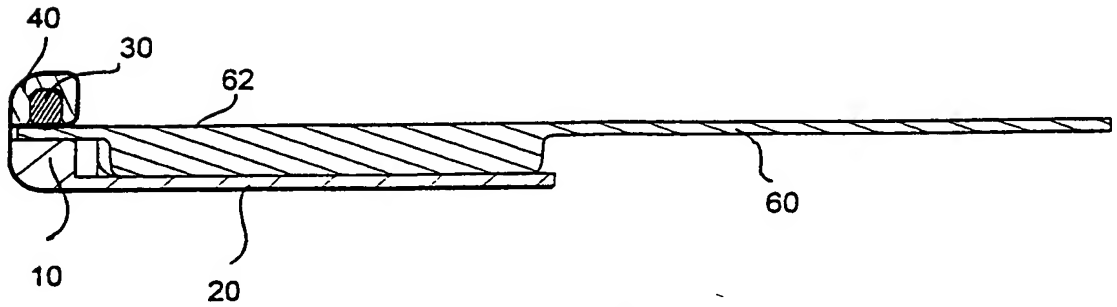


Fig. 5

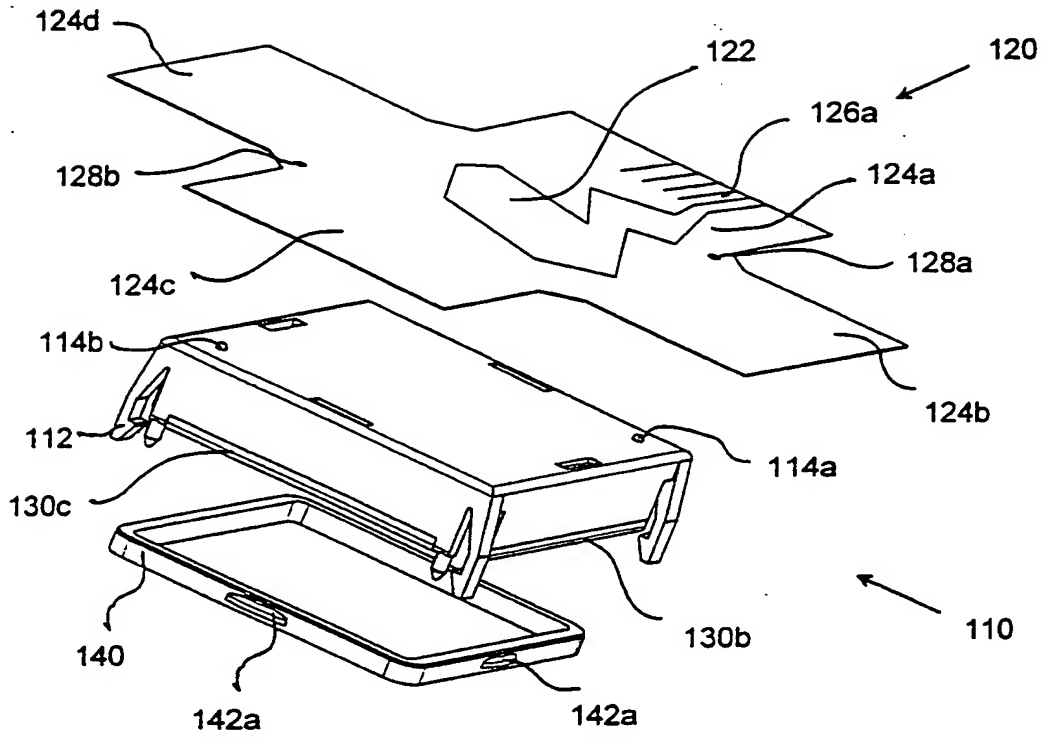
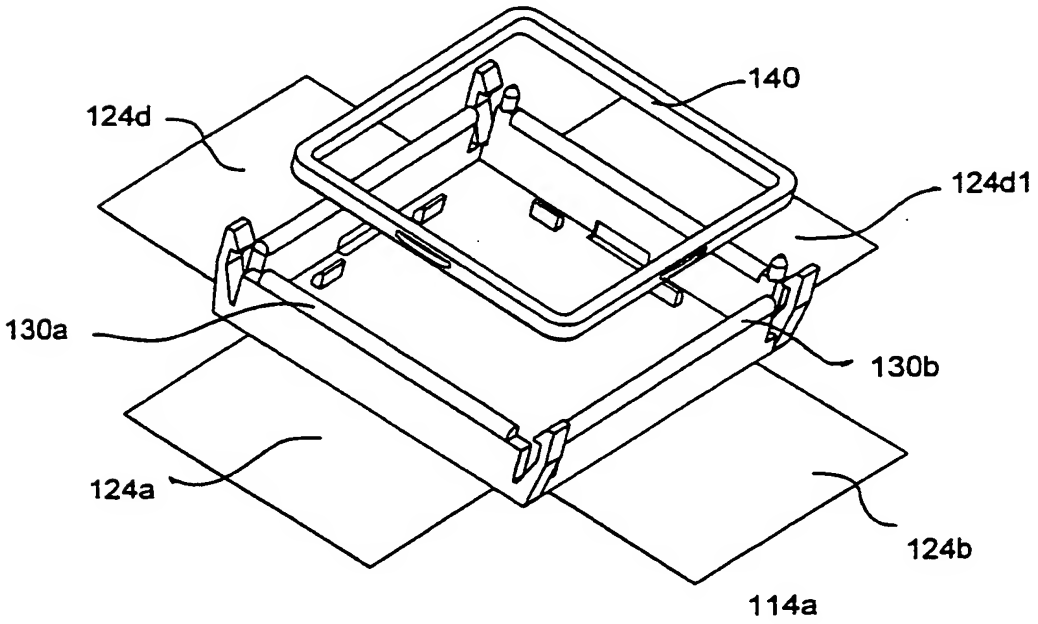

124d
122
120
126a
128b
124a
124c
128a
114b
124b
112
114a
130c
110
130b
140
142a
142a

Fig. 6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124d
124d1
130a
130b
124a
124b
114a

Fig. 7

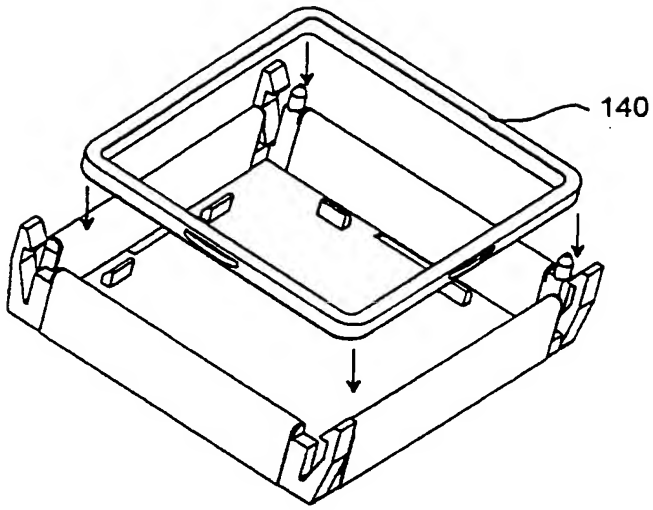

Fig. 8

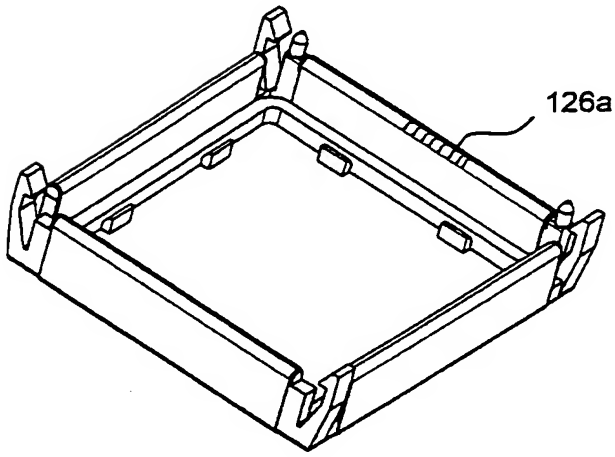

Fig. 9

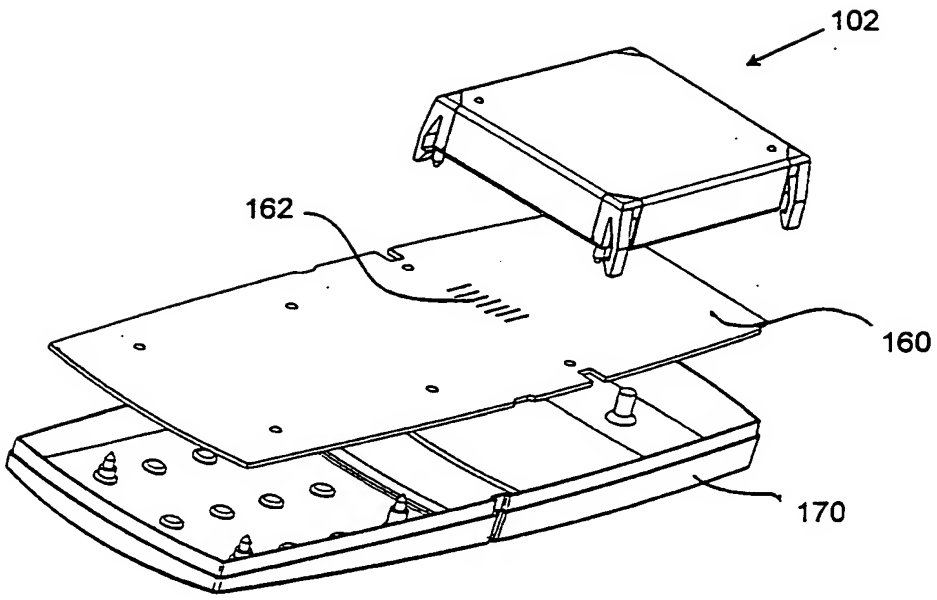

Fig. 10

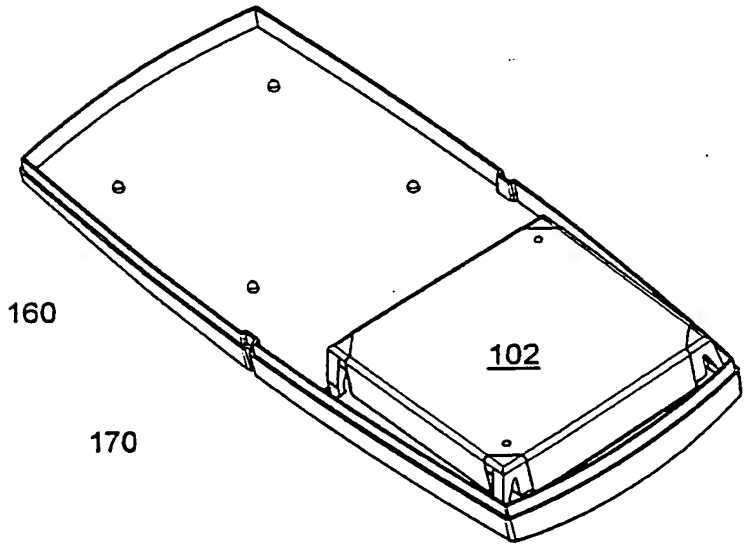

Fig. 11

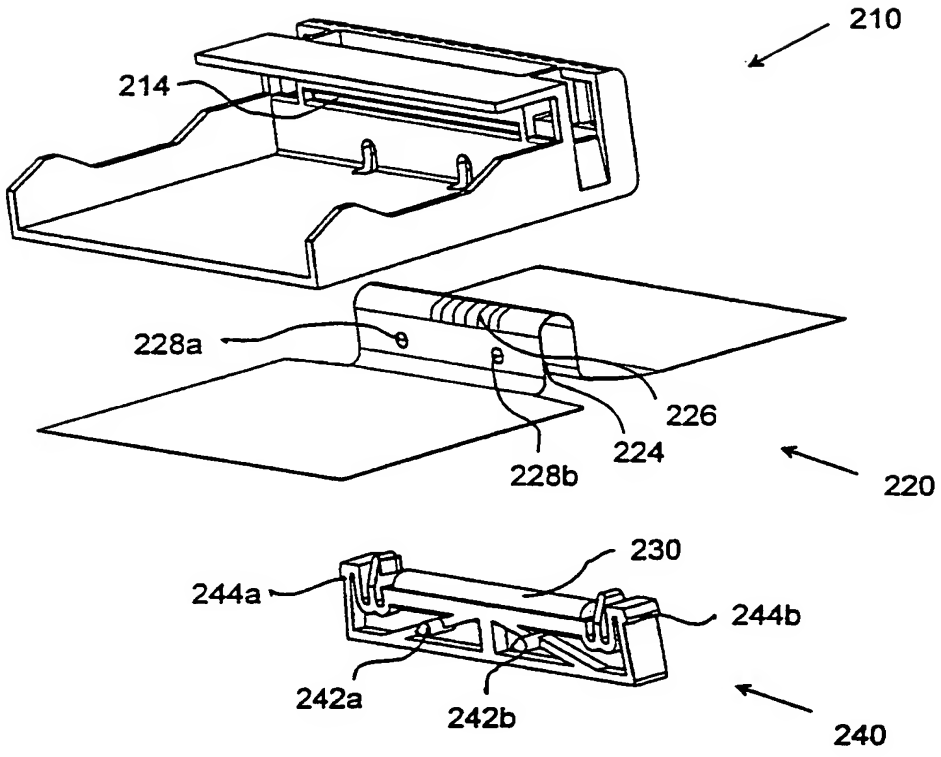
210
214
228a
226
224
228b
220
230
244a
244b
242a
242b
240

Fig. 12

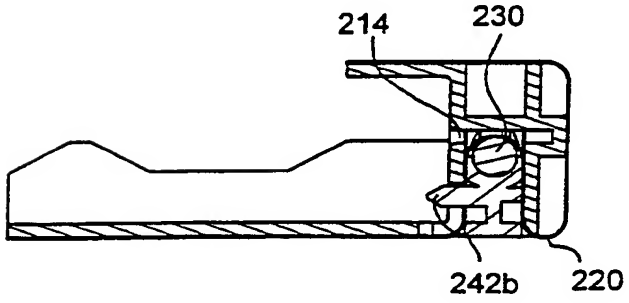
214
230
242b
220

Fig. 13

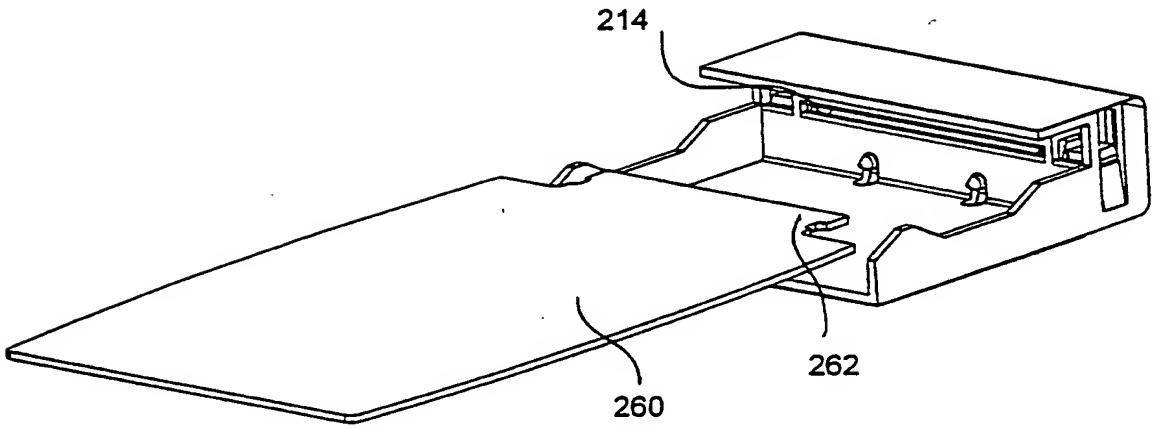

Fig. 14

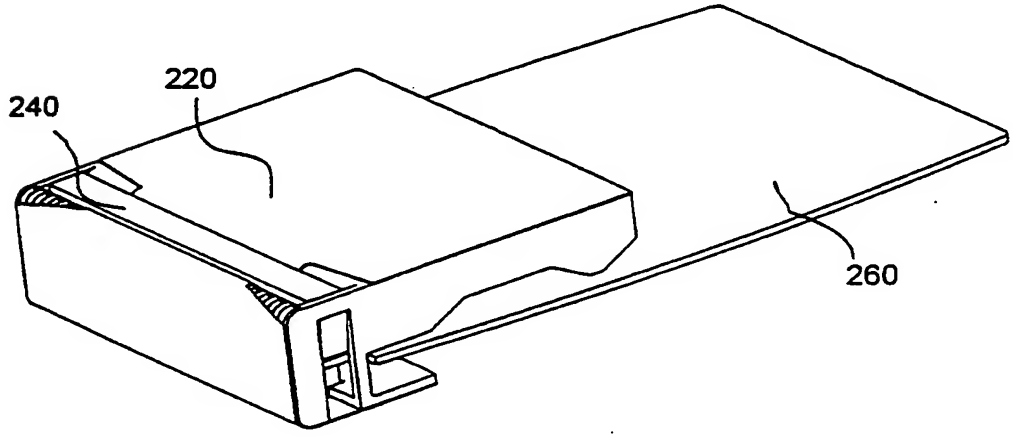

Fig. 15

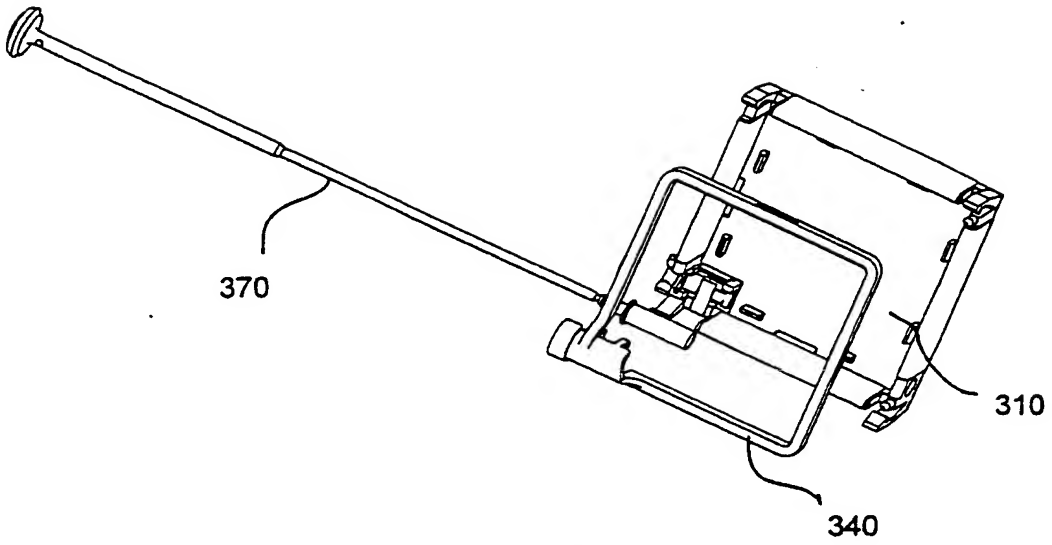

Fig. 16

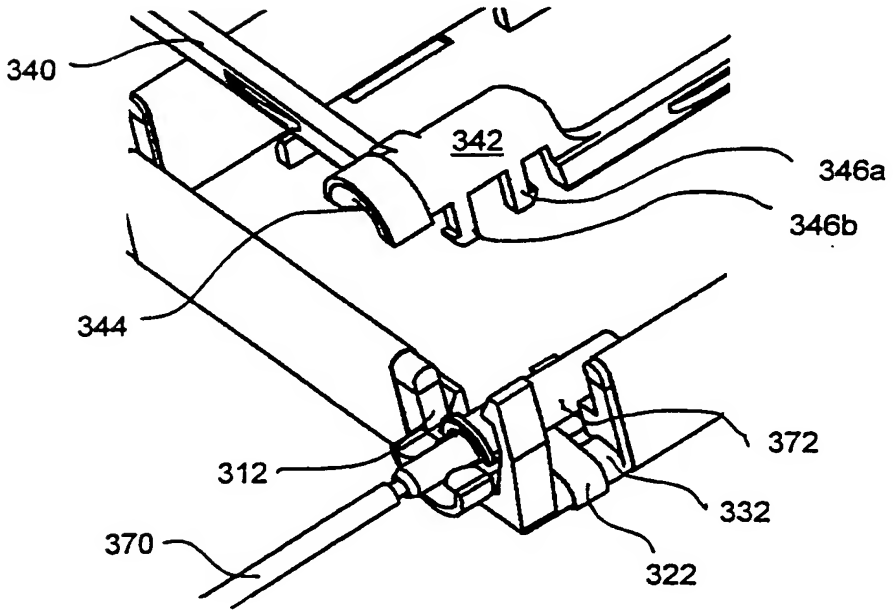

Fig. 17

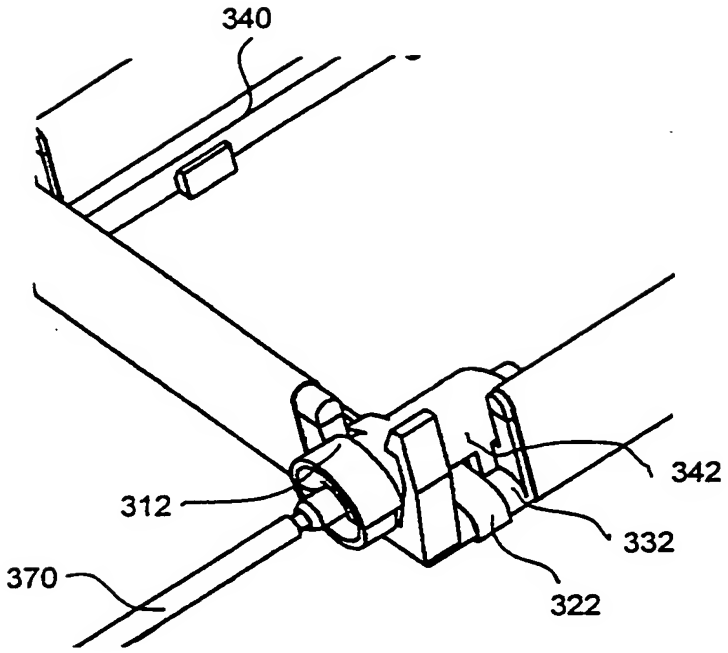

Fig. 18

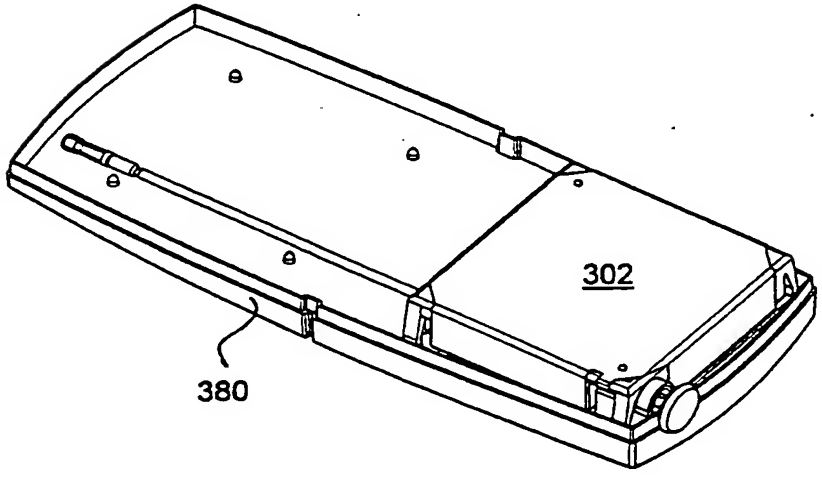

Fig. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/01804

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/24
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5929813 A (STEVE W. EGGLESTON), 27 July 1999 (27.07.99) --	1-20
A	US 5828343 A (JAMES D. MACDONALD, JR ET AL), 27 October 1998 (27.10.98) --	1-20
A	EP 0862278 A2 (NOKIA MOBILE PHONES LTD.), 2 Sept 1998 (02.09.98) -- --------	1-20

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 November 2000	27 -11- 2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson/MN Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/11/00

International application No.
PCT/SE 00/01804

US	5929813	A	27/07/99	BR	9900013	A	21/12/99
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				CN	1217092	A	19/05/99
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				SE	0886893	T3	
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EP	0862278	A2	02/09/98	FI	102927	B	00/00/00
				FI	970618	A	15/08/98